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Observations on the "puddling behavior" of *Delias* species (Lepidoptera, Pieridae) in the central highlands of Irian Jaya

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Abstract Observations on the puddling behavior of *Delias* species were carried out in the central highlands of Irian Jaya, Indonesia in late April, 1991. The puddling behavior and some interesting behavior related to it are described and discussed in the present report.

Key words *Delias*, Pieridae, puddling, pumping, bathing, falling, Irian Jaya, Indonesia.

Introduction

The Genus *Dalias* Hübner has about 200 species (Bridges, 1988) distributed widely from India to New Caledonia. Lots of them inhabit South East Asia, and also diverges remarkably in New Guinea Island (Talbot, 1928-1937). The most remarkable characteristics of the genus *Delias* are the various colorful markings on the underside of hindwings which have generally been believed as the aposematic coloration (Finn, 1897 ; Corbet & Pendlebury, 1956, 1978 ; Yata, 1981) and the larval feeding habit in which most species utilize mistletoe plants, although early stages are still unknown in many species. Talbot (1928-1937) divided this large single genus into 20 groups in his monograph.

I visited Baliem Valley in the central highlands of Irian Jaya, Indonesia for the taxonomic study on *Delias* species of the particular group 6 (Talbot, 1928-1937) in late April, 1991. Then I had a chance to observe the habit of *Delias* species sucking on the wet soil.

The habit of water-drinking is widely known in Lepidoptera and various kinds of behavior have been reported (Clench, 1957 ; Iwase, 1963 ; Ejima, 1977 ; Ishii, 1984). The habit is generally called "puddling behavior" as butterflies in particular land on puddles or humid places for drinking water.

In this report I will describe and discuss the puddling behavior of the *Delias* species in the central highlands of Irian Jaya.

Methods

Observations on the puddling behavior of *Delias* species were made along a branch of the River Úwe at Baliem Valley (2,000 m alt., 138°40′E., 3°50′S.) in late April, 1991. I selected a site on a sunny and humid place on a mountain path running through a primary forest, and a stream crossed the path there (Fig. 1).

I made a preliminary observation and examined the species of *Delias* on the 27th of April and defined the behavior as landing on the place and extending the proboscis for more than 10 seconds. On the 28th and 29th of April, the number of individuals which took the puddling behavior were totally counted for each species at the intervals of 20 minutes from 10 a.m. when they began to gather till the early afternoon when they went away from the place or it began to rain. The weather and temperature were recorded at the same intervals.

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Fig. 1. The place (A) where observations were carried out and its circumstances.

Results

Sixteen *Delias* species and twelve other species of butterflies were found in this area (Table 1). *Delias arabuana* was newly recorded in this area.

No *Delias* species were observed before about 9 : 00 in the morning when the temperature was between 18℃ and 20℃. At about 9 : 00 a.m. *Delias toxopei* began to fly ahead only on fine or slightly cloudy occasions with a temperature of 20℃ or higher. After a short time several *Delias* species such as *D. catisa, D. flavistrigaa, D. leucias, D. argentata, D. zebra, D.* meeki began to fly rapidly alone or together along or across the path and sometimes perched on leaves of trees along the path. These types of behavior were usually observed at 3-5 m above the ground excepting the cloudy occasions where they scarcely flew about.

Fifteen *Delias* species were observed to puddle at the observation site on the 28th and 29th of April, 1991 (Table 2). At about 10 : 00 a.m. on both days, *Delias* species flying high and rapidly flew down slowly and gradually to the wet place with circling. They flew about slowly above the place for a while before landing for drinking water. After they sometimes flew up and returned, and repeated the behavior for more than 1 hour, they concentrated on drinking water in the midnoon. At around 0 : 30 p.m., they were released from concentration on it and sometimes flew slowly before almost all of them flew away at 1 : 30 p.m. Various peculiarities observed in the present survey are summerized as follows.

Their puddling behavior was observed only when it was fine or slightly cloudy with a temperature of 20℃ or more. When it became cloudy, they stopped it and soon went away if such weather conditions continued. All of them were fresh males as if they had just emerged except one broken male of *D. catisa*, and closed both pairs of wings in the puddling assemblages. Although sizes of the asemblages were generally small with less than 10 males (Fig. 2), those of more than 30 males including several species were sometimes observed. *D. toxopei* was sometimes seen congregating at around any substance of bluish color (Fig. 3).

Habitual differences were found between the two closely allied species *D. toxopei* and *D. catisa*. The former had puddling behavior continuously from 10 : 00 a.m. to 1 : 20 p.m.,

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Table 1. *Delias* and other species of butterflies found at Baliem Valley and its vicinities in the central highlands of Irian Jaya between 27th and 29th Apr. 1991.

Delias	*microsticha microsticha* Rothschild & Jordan, 1904
D.	*hypomelas lieftincki* Roepke, 1955
D.	*argentata* Roepke, 1955
D.	*fascelis iberana* Roepke, 1955
D.	*balimensis* Roepke, 1955
D.	*approximata* Joicey & Talbot, 1922
D.	*catisa aurostriga* Roepke, 1955
D.	*toxopei toxopei* Roepke, 1955
D.	*zebra* Roepke, 1955
D.	*arabuana* Roepke, 1955*
D.	*flavistriga* Roepke, 1955
D.	*hapalina amoena* Roepke, 1955
D.	*leucias leucias* Jordan, 1911
D.	*rosamontana* Roepke, 1955**
D.	*mira automunalis* Roepke, 1955
D.	*meeki hypoxantha* Roepke, 1955
Graphum weiskei (Ribbe, 1900)	
Eurema hecabe octa Fruhstorfer, 1906	
Leuciacria acuta Rothschild & Jordan, 1905	
Danaus plexippus (Linnaeus, 1758)	
Mycalesis discobolus Fruhstorfer, 1906	
Precis villida (Fabricius, 1787)	
Argyreus hyperbius (Linnaeus, 1763)	
Polyura jupiter jupiter Butler, 1869	
Udara drucei Bethune-Baker, 1906	
Notocrypta caerulea Evans, 1928	
Hesperiidae sp.	
Hesperiidae sp.	

* The first record in Baliem Valley.
** Only one male was observed on the first day.

whereas the latter seemed to have it at intervals and also was not as fond of it as the former. It seemed not to depend on the difference of their population densities because the both species were common there and then. Moreover, *D. toxopei* flew more quickly at a height of 10-30 cm above the ground, whereas *D. catisa* slowly at 30-50 cm above the ground. Some interesting behavior related to the puddling were also observed: "pumping" (draining water from abdomen like shooting, Fig. 6) in *D. toxopei*, "bathing" (same as dipping in moths, diving to water and flying up instantly, Fig. 7) in *D. microsticha, D. argentata, D. leucias* and *D. mira*, and "falling" (falling down immediately after flying up from the ground and repeating it some times, Fig. 8) in *D. toxopei*. All the *Delias* species were concentrated on the puddling behavior between 11 : 30 a.m. and 12 : 30 p.m. with their wings motionless (Figs 4-5).

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Table 2. Total number of *Delias* species that had puddling behavior per every 20 minutes.

Time		10: 00	20	40	11: 00	20	40	12: 00	20	40	13: 00	20	
28. iv. 1991	Weather* and temperature (℃)	F 20	F 21	F 22	F 23	LC 22	LC 21	F 20	F 20	R —			
29. iv. 1991	Weather* and temperature (℃)	C-F 20-22	F 22	LC 22	LC 20	LC 20	F 22	F 23	F 24	F 24	F 25		total
microsticha		1	1	2	2	1 2	2 2	2					11 4
hypomelas								1					0 1
argentata		3	3 3	2 2	1 2	2	2 2	2 3	3 4				13 21
fascelis							1	1					2 0
balimensis or *approximata*					2	3	3	4	3				15 0
catisa		3 1	2 2				1**		5	1			6 9
toxopei		2 3	4	3 4	4 4	3 5	6	2 6	2 10	6	2		17 50
zebra		1	2	1 2				2	2 2	1			6 7
arabuana								1					0 1
flavistriga			1		2	2	1	1	1				5 3
hapalina									1				1 0
leucias				3	2 2	3 3	4	3 5					15 10
mira			1	2		2	2	1					8 0
meeki		2	2 2	2	2 2	3 1	2 1	3	3 1				15 11
total	28. iv. 1991	7	12	13	15	15	17	19	16	0	0		114
	29. iv. 1991	9	11	10	10	15	12	18	22	8	2		117

* Abbreviations are F=fine, LC=a little cloudy, C=cloudy, and R=rainy.

** Broken male, probably a few days passed after emergence.

Discussion

First of all I realized actually that *Delias* species are remarkably numerous compared with the various other areas where I have been. I agree to the idea that *Delias* species markedly diverged in the highlands of New Guinea Island. As for the puddling behavior, it is an interesting habit of *Delias* species in the highlands of New Guinea Island. Although I have observed lots of *Delias* species (more than 10 species) in South East Asia, such as in the Philippines, Malaysia, Java and Bali Island, I have never seen the habit. Since in *D. belladonna* distributed mainly in the south of the Asiatic Continent, the puddling behavior has been known, the habit for *Delias* species may not be restricted to the highlands of New Guinea Island. Nevertheless, it still seems intriguing of *Delias* species in the highlands of

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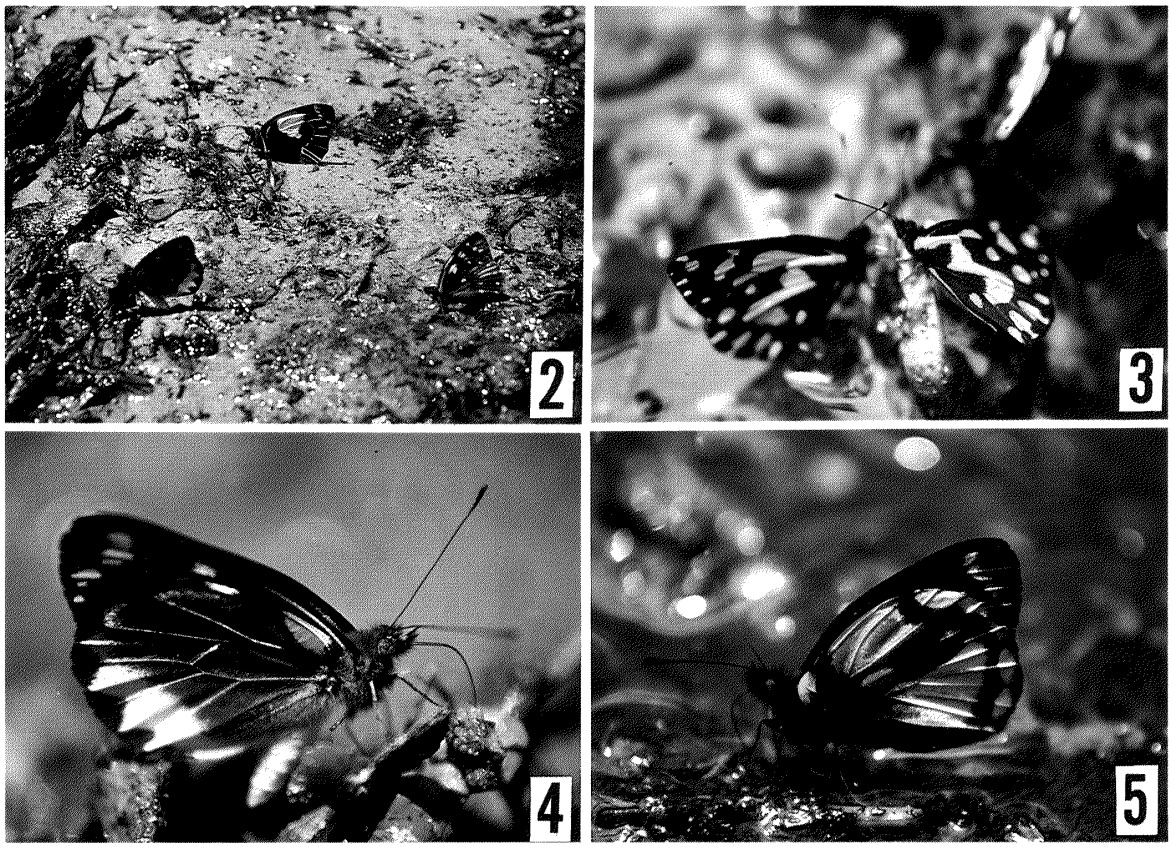

Fig. 2. Puddling assemblage (usually the butterflies were solely puddling and some species were mixed). Fig. 3. Congregating of *Delias toxopei*. Figs 4-5. *Delias* species that had puddling behavior. 4 : *D. mira* 5 : *D. argentata*.

New Guinea Island owing to the fact that almost all of *Delias* species there are remarkably fond of puddling.

The meaning of the behavior related to puddling is considered as follows :

1) Pumping. The well-known behavior in some papilionid and pierid butterflies and also some moths. It may be the physical necessity of draining the water because of drinking rapidly and continuously (Ejima, 1977 ; Ishii, 1984).

2) Bathing (Dipping). Little known behavior. According to the recent report (Matsuka, 1991) of such behavior in *Macroglossum bombylans*, however, it is a behavior to drink water. It seems true in the present observation.

3) Falling. Probably this is the first report. The butterfly may not fly : I consider that it was caused by the increasing weight or the abdomen getting cooler to fly.

Remarks

More than 20 males (total number, same observation as in *Delias* species) of *Graphum weiski* (Papilionidae) and *Leuciacria acuta* (Pieridae) were observed to make the puddling behavior from 10 : 00 a.m. to 0 : 00 p.m. The former scarcely landed, drank water with fluttering, the latter landed with some *Delias* species.

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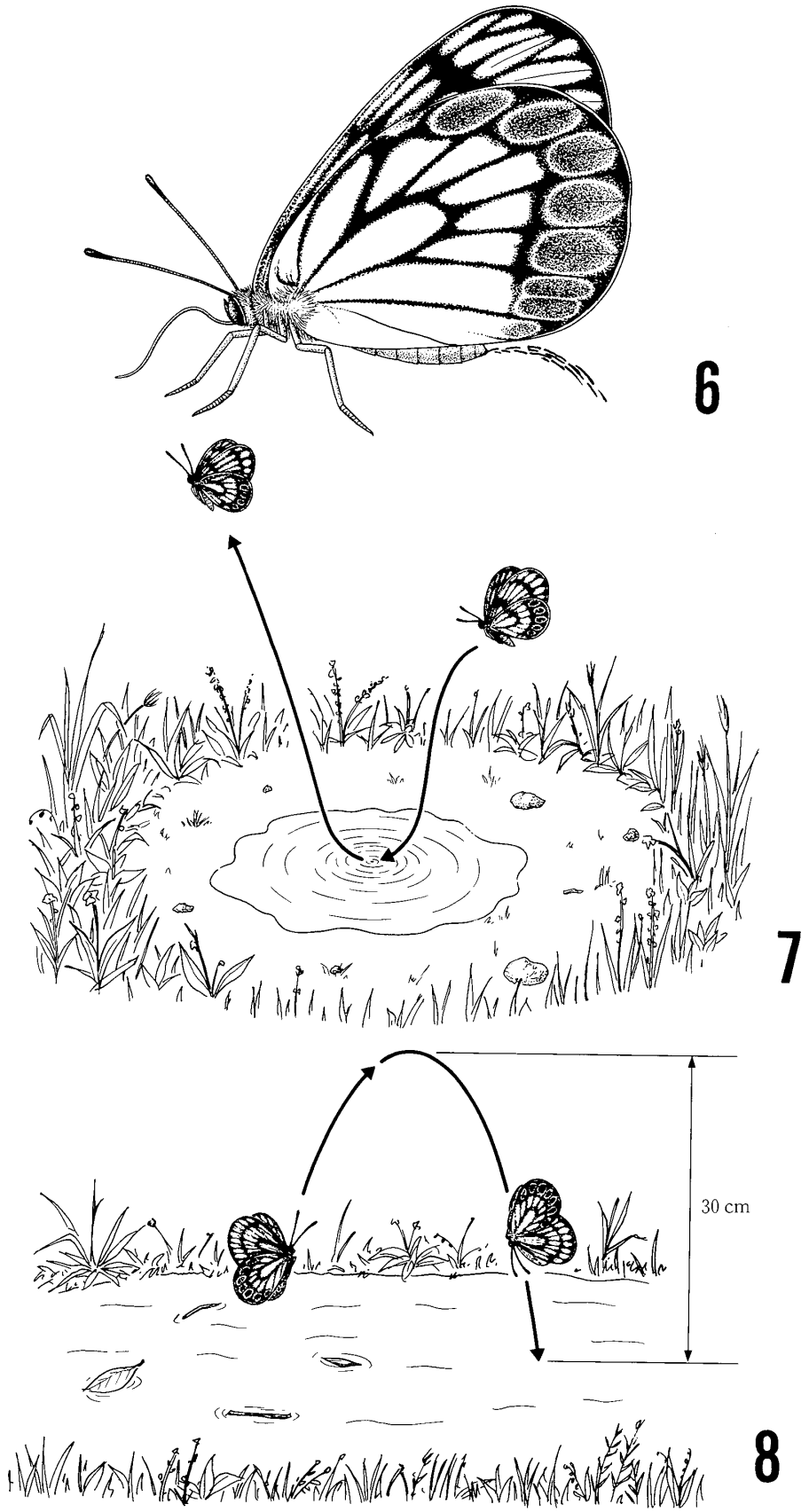

Figs 6-8. Interesting behaviors that were observed. 6: Pumping 7: Bathing 8: Falling.

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Literature

Bridges, A. C., 1988. *Catalogue of Papilionidae & Pieridae* (Lepidoptera: Rhopalocera). **II**: 26-30.

Clench, H. K., 1958. The "pumping" of certain moths at water. *Lepid. News* **11**: 18-21.

Corbet, A. S. & H.M. Pendlebury, 1978. *The Butterflies of the Malay Peninsula.* (3rd ed. revised by Eliot, J. N.): 38-41. Malayan Nature Society, Kuala Lumpur, Malaysia.

Ejima, M., 1977. Tyô no Kyûsui Kôi (1). *Nature Insects* **12** (6): 11-14 (in Japanese).

————, 1977. Tyô no Kyûsui Kôi (2). *Ibid.* **12** (7): 9-13 (in Japanese).

Finn, F., 1897. Contribution to the theory of warning colours and mimicry. IV. Experiments with various birds. *J. Asiat. Soc. Beng.* **66**: 613-668.

Guppy, R. R. R. I., 1952. A living siphon. *Lepid. News* **6**: 43.

Imamori, M., K. Unno, H. Matsuka & S. Yamaguchi, 1984. *Sekai no Tyô*: 48-51. Shogakkan, Japan (in Japanese).

Ishii, M., 1984. Questions about "water-drinking" behavior of butterflies. *Insectarium* **21**: 232-239 (in Japanese).

————, 1985. Life histories of tropical butterflies. *In* Hidaka, T. ed. *Ethological Research of small Animals in the humid Tropics. 1983*: 11-32. Department of Zoology, Kyoto University, Kyoto.

Iwase, T., 1963. Bathing by Butterflies. *Tyô Ga* **14**: 102-103 (in Japanese).

Mastrigt, H. V., 1989. Taxonomy of the *Delias mesoblema* subgroup from Irian Jaya (Lepidoptera: Pieridae). *Ent. Ber., Amst.* **49**: 8-14.

Matsuka, H., 1991. Dip drinking by *Macroglossum bombylans* Boisduval (Lep., Sphingidae). *Yadoriga* (146): 16-18 (in Japanese).

Mori, T., 1982. "Pumping" behavior of *Timandra comptaria* Walker (Geometridae). *Japan. Heterocerists' J.* (119): 308 (in Japanese).

Morishita, K., 1979. The *Belisama* Group of the Pierinae Genus *Delias*. *Chô Chô* **2** (11): 2-34 (in Japanese).

Norris, M. J., 1935. The feeding-habit of the adult Lepidoptera Heteroneura. *Trans. r. ent. Soc. Lond.* **85**: 61-90.

Ohtsu, M., 1981. *Akaeritoribanetyô*. 187 pp. Tsukiji Shokan (in Japanese).

Orr, A. G. & A. Sibatani, 1985. A Revision of the *Delias aroae-cuningputi* complex (Lepidoptera, Pieridae). 1. The *aroae* Group. *Tyô Ga* **36** (1): 1-25.

Pivnick, K. A. & J. N. Mcneil, 1987. Puddling in butterflies: Sodium effects reproductive success in *Thymelicus lineola*. *Physiol. Ent.* **12**: 461-472.

Roepke, W., 1955. The butterflies of the genus *Delias* Hübner (Lepidoptera) in Netherlands New Guinea. *Nova Guinea* (N. S.) **6**: 185-260, pls: 5-8.

Talbot, G., 1928-1937. *A Monograph of the pierine Genus* Delias: 57-79. British Museum, London.

Tanida, M., 1990. Notes on "water-drinking" behavior of the adult Hyblaeidae. *Japan Heterocerists'*

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J. (157) : 97-98 (in Japanese).
Yata, O. & K. Morishita, 1981. *In* Tsukada, E., ed. *Butterflies of the South East Asian Islands* **2**. Pieridae, Danaidae : 305-358. Plapac, Tokyo (in Japanese).

摘　　要

イリアンジァヤ中央高地における *Delias* 属 (鱗翅目，シロチョウ科) の吸水行動の観察
(森中定治)

1991年4月27-29日，*Delias* 属の分類学的研究のためイリアンジァヤ中央高地 (Baliem Valley) を訪れた際，*Delias* 属の吸水行動を観察する機会を得た．そこで，一定の時間間隔で吸水行動を行った種類とその延べ個体数を調査し，その結果を Table 2 に示した．*D. arabuana* はこの地では初記録である．9 : 00 a.m. にまず *D. toxopei* が飛翔を始め，次いで種々の *Delias* 属のチョウが飛翔を始めた．10 : 00 a.m. 頃から，それらは緩やかな飛翔となり，円を描きながら徐々に降りたった．1時間以上着地と穏やかな飛翔を繰り返し，11 : 30 a.m. 頃から着地したままじっと動かず，翅を静止させ，吸水に集中する状態となった．0 : 30 p.m. 以降は，集中から開放され飛翔と着地を繰り返すようになり，1 : 30 p.m. には殆どの個体が飛び去った．吸水は，天候が晴れか薄曇りで，気温が 20℃ 以上の場合にのみ行われた．1頭の *D. catisa* を除き，総てが新鮮な♂であった．吸水は総て翅を閉じて行われた．吸水集団は一般に10頭以下の小さいものであったが，*Delias* 属以外の種も含む30頭以上の集団も時折観察された．近縁種 *D. catisa* と *D. toxopei* の吸水行動の生態的差異を観察し記録した．また，吸水時に興味深い行動を観察し，"pumping", "bathing", "falling" (Figs 6-8) として記録し，その理由を考察した．*Delias* 属の吸水行動は，ニューギニア島固有のものではないが，今回観察された *Delias* 属ほぼ全種の，かつ著しい吸水指向性はニューギニア島高地性 *Delias* 属の興味深い生態的特徴と考えられた．

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